GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: CHEMICAL ENGINEERING PLANT ECONOMICS
(COURSE CODE: 3360502)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	Sixth

1. RATIONALE

A plant-design project moves to completion through a series of stages starting from preliminary evaluation of economics and market to commercial production. Chemical engineering design of a new chemical plant and the expansion or revision of existing one require the use of engineering principles and theories combined with consideration of practical limits imposed by industrial conditions. In this course special emphasis is given on the applied economics and engineering principles involved in the design of chemical plants. Use of these principles is highly required for any successful chemical engineer to work in the area of production, administration, sales, marketing, research, and development of a new chemical project.

2. COMPETENCY

The course content should be taught and curriculum should be implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Design chemical engineering plants considering principles of economics.**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes:

i. Explain basic concepts of process and plant design
ii. Select appropriate piping and equipment
iii. Select appropriate plant location
iv. Prepare general layout (outline diagram) of proposed plant
v. Evaluate economics of a chemical project
vi. Optimise conditions with one and two variables

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**ESE**	**PA**	**ESE**	**PA**	**100**
4	4	0	8	70	30	00	00	

Legends: L - Lecture; **T -** Tutorial/Teacher Guided Student Activity; **P -** Practical; **C -** Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
Unit – I Basics of Process and Plant Design	1a. Describe role of Chemical Engineer 1b. Justify the need of plant design 1c. Explain components of chemical Engineering Design 1d. Describe criteria for good designs 1e. Explain Process design and its components 1f. Describe plant design factors	1.1 Plant designs: Chemical Engineering Designs,Process Design, Equipment Design, Building Design 1.2 Criteria for good design: Process design Technical factors, Economic factors Legal phases, Selection of a process 1.3 Continuous v/s Batch processing Shift and Operating schedules Types of flow diagrams
	1g. Describe process evolution stages	1.4 Process evolution stages and their importance, Logical evolution stages 1.5 Checklist for pilot plant investigation.
Unit – II Selection of Process Equipment and Piping	2a. Plan for selection of equipment 2b. Differentiate Standard and special equipment 2c. Prepare specification sheet for equipments 2d. Select appropriate equipments	2.1 Selection of process equipment 2.2 Standard v/s Special equipment 2.3 Specification sheet for equipment 2.4 Selection of equipments: Size reduction equipment, Heat transfer equipment, 2.5 Mass transfer equipment, Material handling equipment, Pumps
	2e. Explain piping, layout and insulation 2f. Classify different insulation.	2.6 Piping, Pipe strength and wall thickness 2.7 Piping design problems, Piping layout rules, Ferrous and non-ferrous pipe, Non-metallic Piping and tubing, 2.8 Types of insulation, Factors governing selection of insulation.
Unit – III Plant Layout and Location	3a. Describe principles of plant layout 3b. Compare methods of plant layout 3c. Explain factors affecting plant location	3.1 Principles of plant layout 3.2 Methods of plant layout: Unit area Concept, Two-dimensional layout 3.3 Scale models 3.4 Factors for selection of plant location: Primary factors and specific factors
Unit – IV Economic Evaluation of Projects	4a. Evaluate total capital investment 4b. Estimate equipment cost solve the numerical based on cost indices 4c. Explain depreciation 4d. Calculate depreciation using different methods 4e. Identify components of total product cost	4.1 Total Capital Investment, 4.2 Fixed capital investment, Working capital investment 4.3 Equipment cost estimation, Cost-Size 4.4 relation, Cost-Time relation, 4.5 Numerical based on Cost Indices 4.6 Depreciation and it's types 4.7 Methods for determining depreciations 4.8 Arbitrary methods, Methods with interest on investment, Numerical for depreciation 4.9 Total product cost (TPC)
	4f. Estimate profitability	4.10 Profitability analysis: Net and gross earnings, Methods of profitability, Percent return on investment, Pay-out time period,Present worth, Turn-over ratio

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
	4g. Calculate break-even capacity	4.11 Break-even analysis (Analytical method), 4.12 Break-even chart (Graphical method), 4.13 Numerical of Break-even analysis
Unit – V Optimum Design	5a. Explain procedure to find out optimum condition 5b. Estimate the optimum insulation thickness and pipe diameter 5c. Solve numerical to find optimum design	5.1 General procedure for determining optimum condition: Procedure with one variable (Analytical and graphical), Procedure with two variables (Analytical and graphical) 5.2 Optimum economic design for Insulation Thickness and Pipe diameter 5.3 Numerical for optimum design

6. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (Theory)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Process and Plant Design	12	5	5	5	15
II	Selection of Process Equipment and Piping	12	5	5	5	15
III	Plant Layout and Location	07	2	5	2	09
IV	Economic Evaluation of a Project	17	7	7	7	21
V	Optimum Design	08	2	3	5	10
Total		**56**	**21**	**25**	**24**	**70**

Legends: R = Remember**, U** = Understand**, A=** Apply and above Level (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED TUTORIALS

In tutorials numerical or conceptual problems may be given to individual or group of students. Students should be first allowed to struggle on their own to find the solution, and should try their creativity. However, faculty should remain around the students and help them if they are not able to proceed.

It is better if real life problems are case studies are given where different groups of students may come out with different solutions, which can be discussed in a larger group of student to generate more discussions. Following is the suggestive list of exercises; concerned faculty may change/add exercises to this list.

S. No.	Unit No.	Tutorial Exercises	Approx. Hours Required
1	I	Prepare block type and equipment flow diagram for production of desired (quantity and quality) chemical	4
2	I	Prepare block type material balance flow diagram for production of desired (quantity and quality) chemical	8
3	I	Prepare block type energy balance flow diagram for production of desired (quantity and quality) chemical	4

S. No.	Unit No.	Tutorial Exercises	Approx. Hours Required
4	II	Prepare detailed process and instrumentation flow diagram for production of desired (quantity and quality) chemical	4
5	II	Prepare specification sheet for 1-2 shell and tube heat exchanger	4
6	II	Prepare specification sheet for packed type distillation column	4
7	III	Solve given simple problems using cost–size relationship and cost- time relationship (Cost indices)	4
8	III	Calculate depreciation using Straight line method for given plant	2
9	III	Calculate depreciation using Declining balance method for given plant	2
10	III	Calculate depreciation using Sum of the years digits method for given plant	2
11	III	Calculate depreciation using Sinking fund method for given plant	2
12	III	Find-out break-even point Using Analytical and Graphical methods for given plant	8
13	IV	Solve given simple problems to determine optimum value using one variable and two variable methods. (Graphical and Analytical methods)	8
Total Hours			**56**

8. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

i. Explore internet, visit websites of reputed chemical production companies and prepare ppt presentations on different topics (in group of four-five) and present in class
ii. Study (in group of four-five) the design of some real chemical plant and identify good features of design and also weaknesses in it, present in class to have a group discussion.

9. SPECIAL INSTRUCTIONAL STRATEGY (IF ANY)

i. Use online course material from reputed universities
ii. Show videos related to good economical designs of plants for production of different chemical products.
iii. Show excel spreadsheets from internet about economic evaluation of chemical plants
iv. Show charts and models of different plants and handouts about their design features and specification of equipment
v. Arrange expert lectures
vi. Discuss real life case studies of good and bad design of chemical plants.

10 SUGGESTED LEARNING RESOURCES

A) Books

S. No.	Title of Books	Author	Publication
1	Plant Design and Economics for Chemical Engineers,	Peters, Max and Klaus Timmerhaus	McGraw Hill, New Delhi, 4th edition
2	Chemical Engineering Plant Design.	Vilbrandt, Frank Carl and Dryden,Charles E.	McGraw Hill, New Delhi, 4th edition
3	Chemical Engineering Design	Towler, Gavin and Sinnott, R. K.	Butterworth-Heinemann (2008)
4	Process Engineering Economics	Couper, James R.	Marcel and Dekker

B) Major Equipment/Materials with Broad Specifications

i. Charts and Models
ii. Specification sheets of equipment from fabricator
iii. Commercial project report

C) Software/Learning Websites

i. www.cheresources.com
ii. http://people.clarkson.edu/~wwilcox/Design/refcosts.htm
iii. http://app.knovel.com/web/toc.v/cid:kpCEDPPEP4
iv. https://www.lib.utexas.edu/chem/info/chemengecon.html
v. http://www.mhhe.com/engcs/chemical/peters/data/ce.html

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. Kartik R. Desai**, Head, Chemical Engg. Dept., N. G. Patel Polytechnic, Isroli-Afwa
- **Prof. D. H. Joshi**, Lecturer, Chemical Engg. Dept., G. P. Valsad
- **Prof. P. D. Chaudhari**, Lecturer, Chemical Engg. Dept., G. P. Valsad
- **Prof. J. R. Vadher**, Lecturer, Chemical Engg. Dept., Shri BPTI, Bhavnagar

Coordinators and Faculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur**. Associate Professor, Department of Applied Sciences
- **Dr. Joshua Earnest**, Professor of Electrical & Electronics Engineering.